

## § 29.151

- (iv) Turning flight;
- (v) Autorotation; and
- (vi) Landing (power on and power off).

(b) The margin of cyclic control must allow satisfactory roll and pitch control at  $V_{NE}$  with—

- (1) Critical weight;
- (2) Critical center of gravity;
- (3) Critical rotor r.p.m.; and

(4) Power off (except for helicopters demonstrating compliance with paragraph (f) of this section) and power on.

(c) Wind velocities from zero to at least 17 knots, from all azimuths, must be established in which the rotorcraft can be operated without loss of control on or near the ground in any maneuver appropriate to the type (such as crosswind takeoffs, sideward flight, and rearward flight), with—

- (1) Critical weight;
- (2) Critical center of gravity;
- (3) Critical rotor r.p.m.; and

(4) Altitude, from standard sea level conditions to the maximum takeoff and landing altitude capability of the rotorcraft.

(d) Wind velocities from zero to at least 17 knots, from all azimuths, must be established in which the rotorcraft can be operated without loss of control out-of-ground effect, with—

- (1) Weight selected by the applicant;
- (2) Critical center of gravity;
- (3) Rotor r.p.m. selected by the applicant; and

(4) Altitude, from standard sea level conditions to the maximum takeoff and landing altitude capability of the rotorcraft.

(e) The rotorcraft, after (1) failure of one engine, in the case of multiengine rotorcraft that meet Transport Category A engine isolation requirements, or (2) complete power failure in the case of other rotorcraft, must be controllable over the range of speeds and altitudes for which certification is requested when such power failure occurs with maximum continuous power and critical weight. No corrective action time delay for any condition following power failure may be less than—

- (i) For the cruise condition, one second, or normal pilot reaction time (whichever is greater); and
- (ii) For any other condition, normal pilot reaction time.

## 14 CFR Ch. I (1–1–11 Edition)

(f) For helicopters for which a  $V_{NE}$  (power-off) is established under § 29.1505(c), compliance must be demonstrated with the following requirements with critical weight, critical center of gravity, and critical rotor r.p.m.:

(1) The helicopter must be safely slowed to  $V_{NE}$  (power-off), without exceptional pilot skill after the last operating engine is made inoperative at power-on  $V_{NE}$ .

(2) At a speed of 1.1  $V_{NE}$  (power-off), the margin of cyclic control must allow satisfactory roll and pitch control with power off.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5084, 29 FR 16150, Dec. 3, 1964, as amended by Amdt. 29-3, 33 FR 965, Jan. 26, 1968; Amdt. 29-15, 43 FR 2326, Jan. 16, 1978; Amdt. 29-24, 49 FR 44436, Nov. 6, 1984; Amdt. No. 29-51, 73 FR 11001, Feb. 29, 2008]

### § 29.151 Flight controls.

(a) Longitudinal, lateral, directional, and collective controls may not exhibit excessive breakout force, friction, or preload.

(b) Control system forces and free play may not inhibit a smooth, direct rotorcraft response to control system input.

[Amdt. 29-24, 49 FR 44436, Nov. 6, 1984]

### § 29.161 Trim control.

The trim control—

(a) Must trim any steady longitudinal, lateral, and collective control forces to zero in level flight at any appropriate speed; and

(b) May not introduce any undesirable discontinuities in control force gradients.

[Doc. No. 5084, 29 FR 16150, Dec. 3, 1964, as amended by Amdt. 29-24, 49 FR 44436, Nov. 6, 1984]

### § 29.171 Stability: general.

The rotorcraft must be able to be flown, without undue pilot fatigue or strain, in any normal maneuver for a period of time as long as that expected in normal operation. At least three

landings and takeoffs must be made during this demonstration.

**§ 29.173 Static longitudinal stability.**

(a) The longitudinal control must be designed so that a rearward movement of the control is necessary to obtain an airspeed less than the trim speed, and a forward movement of the control is necessary to obtain an airspeed more than the trim speed.

(b) Throughout the full range of altitude for which certification is requested, with the throttle and collective pitch held constant during the maneuvers specified in § 29.175(a) through (d), the slope of the control position versus airspeed curve must be positive. However, in limited flight conditions or modes of operation determined by the Administrator to be acceptable, the slope of the control position versus airspeed curve may be neutral or negative if the rotorcraft possesses flight characteristics that allow the pilot to maintain airspeed within  $\pm 5$  knots of the desired trim airspeed without exceptional piloting skill or alertness.

[Amdt. 29-24, 49 FR 44436, Nov. 6, 1984, as amended by Amdt. No. 29-51, 73 FR 11001, Feb. 29, 2008]

**§ 29.175 Demonstration of static longitudinal stability.**

(a) *Climb.* Static longitudinal stability must be shown in the climb condition at speeds from  $V_Y - 10$  kt to  $V_Y + 10$  kt with—

- (1) Critical weight;
- (2) Critical center of gravity;
- (3) Maximum continuous power;
- (4) The landing gear retracted; and
- (5) The rotorcraft trimmed at  $V_Y$ .

(b) *Cruise.* Static longitudinal stability must be shown in the cruise condition at speeds from  $0.8 V_{NE} - 10$  kt to  $0.8 V_{NE} + 10$  kt or, if  $V_H$  is less than  $0.8 V_{NE}$ , from  $V_H - 10$  kt to  $V_H + 10$  kt, with—

- (1) Critical weight;
- (2) Critical center of gravity;
- (3) Power for level flight at  $0.8 V_{NE}$  or  $V_H$ , whichever is less;
- (4) The landing gear retracted; and
- (5) The rotorcraft trimmed at  $0.8 V_{NE}$  or  $V_H$ , whichever is less.

(c)  *$V_{NE}$ .* Static longitudinal stability must be shown at speeds from  $V_{NE} - 20$  kt to  $V_{NE}$  with—

- (1) Critical weight;
- (2) Critical center of gravity;
- (3) Power required for level flight at  $V_{NE} - 10$  kt or maximum continuous power, whichever is less;
- (4) The landing gear retracted; and
- (5) The rotorcraft trimmed at  $V_{NE} - 10$  kt.

(d) *Autorotation.* Static longitudinal stability must be shown in autorotation at—

(1) Airspeeds from the minimum rate of descent airspeed  $- 10$  kt to the minimum rate of descent airspeed  $+ 10$  kt, with—

- (i) Critical weight;
- (ii) Critical center of gravity;
- (iii) The landing gear extended; and
- (iv) The rotorcraft trimmed at the minimum rate of descent airspeed.

(2) Airspeeds from the best angle-of-glide airspeed  $- 10$  kt to the best angle-of-glide airspeed  $+ 10$  kt, with—

- (i) Critical weight;
- (ii) Critical center of gravity;
- (iii) The landing gear retracted; and
- (iv) The rotorcraft trimmed at the best angle-of-glide airspeed.

[Amdt. No. 29-51, 73 FR 11001, Feb. 29, 2008]

**§ 29.177 Static directional stability.**

(a) The directional controls must operate in such a manner that the sense and direction of motion of the rotorcraft following control displacement are in the direction of the pedal motion with throttle and collective controls held constant at the trim conditions specified in § 29.175(a), (b), (c), and (d). Sideslip angles must increase with steadily increasing directional control deflection for sideslip angles up to the lesser of—

(1)  $\pm 25$  degrees from trim at a speed of 15 knots less than the speed for minimum rate of descent varying linearly to  $\pm 10$  degrees from trim at  $V_{NE}$ ;

(2) The steady-state sideslip angles established by § 29.351;

(3) A sideslip angle selected by the applicant, which corresponds to a sideforce of at least  $0.1g$ ; or

(4) The sideslip angle attained by maximum directional control input.

(b) Sufficient cues must accompany the sideslip to alert the pilot when approaching sideslip limits.